TRANSACTIONS

OF THE

ILLUMINATING ENGINEERING SOCIETY

FOUNDED IN LONDON 1909 INCORPORATED 1930

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VOLUME III—No. 5
MAY, 1938

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LONDON SW1

THE REPORT OF THE DEPARTMENTAL COMMITTEE ON STREET LIGHTING

By J. W. T. WALSH, M.A., D.Sc. *(Member).*

(Paper read on Tuesday, February 8th, 1938.)

Introduction.

In June, 1934, the then Minister of Transport, Mr. Oliver Stanley, appointed a committee to advise him on the subject of street lighting, the terms of reference being "to examine and report what steps could be taken for securing more efficient and uniform street lighting with particular reference to the convenience and safety of traffic and with due regard to the requirements of residential and shopping areas, and to make recommendations." A glance at the membership of this committee will show that of the eight members (other than the chairman) four might be regarded as lighting specialists, two were engineers responsible for advising important local authorities with regard to the street-lighting in their areas, and two were Government officials concerned with the administrative aspects of the subject. The chairman was Major F. C. Cook, C.B., Chief Engineer (Roads Department) in the Ministry of Transport.

It was natural that after the appointment of this committee had been announced, some local authorities showed a disinclination to embark on any considerable schemes for new or improved street lighting until they could obtain at least some indication of the probable nature of the committee's recommendations. For this reason the committee thought it expedient to prepare as quickly as possible an interim report giving sufficient information to enable local authorities to proceed immediately with such work as they were most anxious to undertake. This interim report was published in September, 1935, and contained fairly definite recommendations as regards such fundamental matters as the mounting height, spacing, and siting of lamps. It also made recommendations of a less definite nature with regard to the amount of light to be provided, and the avoidance of glare. The recommendations with regard to administration and finance have been taken *en bloc* into the final report and so will be mentioned later. In the interim report the committee confined their attention to traffic routes which were defined as " all those roads which form the main approaches to or traverse important centres of population, or pass through detached built-up areas, and on which there is appreciable pedestrian traffic."

In November of last year the final report of the committee was published and the object of the present paper is to point out the principal features of that report so as to direct the discussion which is to follow. No attempt has been made to give a critical appreciation of the recommendations; on the contrary, care has been taken to avoid any expression of opinion in the belief that criticisms and opinions will find their natural and proper place in the remarks of those taking part in the discussion.

Administration and Finance.

The first part of the committee's interim report dealt with matters which, although they were in a sense non-technical, nevertheless were bound to influence considerably the effectiveness with which the technical recommendations in the report might be expected to be carried out. In the first place it was recommended that " consideration should be given to the responsibility for the lighting of classified roads (and such other roads as may be agreed) being confined to large administrative units . . . . . " In the second place the committee draw attention " to the suggestion that grants should be provided from national funds (to an extent to be determined) towards the cost of lighting so much of the system of classified roads (as adopted by the Ministry of Transport) upon which public lighting may be regarded as necessary and such other roads as the responsible Government department may agree to include for the purpose." In paragraph seven of their final report the committee have fully endorsed both these recommendations. They also note the power given to the Minister of Transport by the Trunk Roads Act, 1936 (Section 6 (4)) to light any of the 4,500 miles of trunk roads for which he is responsible under that Act.

As a matter which is clearly connected with the desirability of having larger lighting authorities, reference may be made here to the committee's recommendation " that the committee (of a local authority) concerned with street lighting should be advised by an engineer competent to deal with the problems which arise; that a whole-time specialist should be appointed in the case of the larger or more important areas; and that where circumstances did not warrant a whole-time appointment the situation might be met if the engineer to the authority had made a special study of street lighting, or by the appointment of an officer who had specialised in street lighting practice and whose time should be allocated as far as necessary to the planning and maintenance of installations."

Sources of Information.

Before going on to consider in detail the various recommendations of the committee with regard to the technical aspects of street lighting, it is interesting to note that a number of organisations interested in the subject from different points of view gave evidence, both written and oral. Among these organisations were our own society, the Association of Public Lighting Engineers, and the

National Illumination Committee. Further, some organisations submitted memoranda commenting on the interim report. That the committee made considerable use of the information contained in the evidence put before it is clear from the repeated references which appear throughout the report.

In addition to making use of the valuable sources of information just mentioned, the committee arranged for experimental work to be carried out on a roadway (actually Lonsdale-road, Barnes) where a special installation was erected so that the effects of variation of mounting height, spacing, overhang, light output, etc., could be studied under controlled conditions. Finally it may be mentioned that the committee made a large number of inspections of existing installations in different parts of London and in Sheffield and collected technical information on specific points from many different sources.

Classification of Roads.

It will be noticed that for the purposes of their report the committee have divided roads into two main categories. The roads in the first group are designated "traffic routes," and the committee are at some pains to indicate what kind of thoroughfare they have in mind when making recommendations with regard to the lighting of such roads. The classification of thoroughfares is always a matter of considerable difficulty, and it will be remembered that in the preface to the British Standard Specification for Street Lighting the objections to a classification based on traffic density or any similar considerations are pointed out very convincingly. In the committee's final report no fewer than nine paragraphs are devoted to this subject of classification, and in the first five of these the various methods of grouping are mentioned, and the arguments are set out which led the committee finally to adopt a very broad and simple classification into two groups, referred to subsequently as Groups A and B.

Group A comprises all the thoroughfares which were dealt with in the interim report, and were there described as "traffic routes." In that report a traffic route was defined as quoted above, while in the final report thoroughfares in Group A—Traffic Routes—are defined as "roads on which the standard of lighting should provide an ample margin of safety for all road users, without the use of headlights by motor vehicles." All other roads "which the responsible authority considers should be lighted" then fall automatically into Group B.

It is inevitable that in this, as, indeed, in any system of classification, doubts will sometimes arise as to the group in which a certain thoroughfare should be placed. The onus of decision must rest on the lighting authority "with due regard to all relevant conditions," and bearing in mind the guiding principle that if the road carries any appreciable load of through traffic so that the use of headlights is considered undesirable, that road should properly be placed in Group A. This does not mean that headlights will necessarily always be employed by vehicles using thoroughfares in Group B; a lower speed, or familiarity with the locality may make it possible for a driver to proceed quite safely without headlights in such roads. The important difference is that in a road in Group B the decision with regard to the use of headlights is left to the driver; in a road in Group A, if it is lighted at all, *headlights should not be used*, and the lighting should be such as to render them entirely unnecessary.

It will be clear that the driver of a vehicle should never be left in any doubt whether the particular thoroughfare in which he happens to be travelling at any moment is in Group A or Group B. For this reason the committee recommend a definite discontinuity in the degree of lighting provided, so that the two classes of roads may be clearly differentiated in this respect, and it will be seen that the principle has been applied not only to the amount of light which it is recommended should be provided, but also to such immediately obvious characteristics of an installation as mounting height and spacing.

Technical Recommendations: Group A.

The various technical recommendations made by the committee in their interim report, with regard to the lighting of traffic routes, are, in the main, endorsed and elaborated in the final report. It will be convenient to take these *seriatim* under the headings (a) mounting height, (b) spacing, (c) overhang, (d) number and power of sources, (e) distribution of light from the fittings, (f) avoidance of glare, and (g) siting of posts.

The mounting height recommended in the interim report (para. 23) was "in general" 25 ft., and, although this raised some criticism, "mainly on economic grounds" (para. 31 of the final report), the committee adhere to this figure "for general adoption on traffic routes." In this connection it is interesting to note the general trend of technical opinion abroad with regard to the most suitable mounting height for street lighting fittings. A recent paper on street lighting in Holland* describes installations with mounting heights of 27 ft. and 30 ft., while another, dealing with the lighting of arterial roads outside Paris,† mentions installations with heights of 10 m., 9.5 m., 10.5 m., 9.5 m., and refers to experiments leading to the choice of 9.5 m. A third paper, from U.S.A.,‡ recommends 25 ft. to 30 ft., while a fourth, from Belgium,§ advocates 6 m. to 8 m. for main roads, but 7 m. to 12 m. in towns, according to the width of the road. A more recent paper,¶ describing the new installations in Paris itself, mentions mounting heights ranging from 5 m. to 15 m. It is also noteworthy that the latest edition of the Code of Highway Lighting, issued by the Illuminating Engineering Society of America, states that "Lamps should be mounted at least 25 ft. above grade. Higher mounting heights usually afford greater lighting effectiveness."

With regard to spacing, the committee again endorse the recommendation made in the interim report, viz., an *average* spacing not exceeding 150 ft.,

*R. van Dijk. Light and Lighting, Vol. 29, p. 277, 1936.
†A. Pux. Soc. Franç. des Elect., Bull. Vol. 6, p. 921, 1936.
‡L. A. S. Wood, Elect. J., Vol. 33 p. 459, 1935.
§V. Boulu. Soc. Belge des Elect., Bull. Vol. 53, p. 177, 1937.
¶A. Janet. Rev. Gen. d'Elect., Vol. 42, p. 117, 1937.

with an absolute maximum of 180 ft. for any single span, but they now recommend a still closer spacing, such as 120 ft., " where it is economically practicable." No doubt lighting engineers will welcome this clear recognition of the advantages to be gained by closer spacing of the light sources.

Since the publication of the interim report, the practice has spread very widely of overhanging the light sources some 6 ft. or so from the kerb-line, as recommended in that report. The matter is dealt with in considerably greater detail in the final report, and an attempt is made there to indicate how the amount of overhang should be varied according to the width of the carriageway. Since overhang tends to reduce visibility near the kerb, especially when the road is wet, whereas too great a distance between the rows of light sources causes the central part of the road to appear dark, it is clear that some form of compromise is called for, and the solution presented by the committee is a general rule that the distance between the rows of sources should not exceed 30 ft. The amount of overhang recommended is, therefore, given by the formula $\frac{1}{2}$ (W—30) where W is the width of the carriageway in feet. This implies kerb mounting for roads in which the width of the carriageway does not exceed 30 ft. (for still narrower roads the sources may be mounted behind the kerbs), while for wider roads an overhang will be used which increases as the width of the carriageway increases. For widths of over 40 ft. the formula stated above gives an overhang exceeding 5 ft., but the committee recommend that in such roads the far more satisfactory plan should be adopted of having a third row of sources mounted over the centre line of the carriageway at intervals of not more than three spans in length. Where this plan is practicable the sources at the sides of the road should be mounted over the kerbs. The committee are so convinced of the advantages to be gained by the use of such centrally mounted auxiliary sources that they go so far as to say that for carriageway widths of 50 ft. and over it is impossible to achieve satisfactory lighting without central lamps in addition to the lamps at the sides of the road, and that, even if considerable expense is involved, arrangements should be made for their provision. This recommendation is of very great importance considering the continual tendency to increase the widths of roads coming within the category of " traffic routes," and it cannot fail to produce a marked improvement in the lighting of such roads.

The difficult question of the best arrangement of the sources with respect to the carriageway is dealt with by the committee at considerable length, no fewer than three pages of the report being devoted to the subject. As might be expected, no really hard-and-fast rules are laid down, but the staggered system is recommended for general adoption on straight roads. It is, however, pointed out that in the case of a narrow road fronted by light coloured buildings central suspension may give good results, and further, that this method may have to be adopted in the case of a road bordered by large trees. The use of central or combined central and side mounting has sometimes been advocated when the fittings used give a " cut-off " type of light distribution, so that there is no possibility of causing glare to users of the roadway, but the committee make no recommendation here, pending the accumulation of further experience in the matter.

Single-side mounting is, of course, condemned except at bends for which it is recommended. Paragraph 46 of the report describes at some length the principles which underlie the siting of sources so as to produce a road surface as free as possible from dark streaks or patches. Cross-roads and T-junctions are special cases which have to be treated in accordance with these principles. The committee's discussion of the subject concludes with the important recommendation that " the final positions of the sources should be decided only after inspection of the site by a competent lighting engineer and with due regard to local traffic conditions."

In the important matter of the amount of light to be provided at each lighting point it might, perhaps, have been expected that the committee would make a definite recommendation with, possibly, a generous tolerance on either side of the stated figure. It may therefore have come as a surprise that this course has not been followed but instead a very wide range (nearly 3 to 1) of luminous flux per 100 linear feet of roadway is mentioned. The figures given (3,000 to 8,000 lumens) relate to the luminous output of the lanterns, not of the bare sources, and refer to the average performance of the sources throughout their normal life. It should be mentioned in passing that the figures quoted are for carriageway widths not exceeding 40 ft., i.e., they do not include the centrally mounted units recommended in the case of roads wider than this.

It is interesting to see how the committee's figures work out in practice for some of the sources and types of lantern largely in use for street-lighting at the present time. In the case of an electrical installation the source and the lantern can be taken separately. The efficiency of the lanterns in common use for tungsten filament lamps probably ranges from about 60 to 75 per cent.† and the luminous output of a 750 watt lamp, at mid-life, is about 12,000 lumens. This gives 7,200 to 9,000 lumens from the lantern, so that, for a spacing of 150 feet, the lumens per 100 feet of roadway lie between 4,800 and 6,000. In the case of the lanterns used for discharge lamps the efficiency is normally rather less, say 55 to 65 per cent. Since the luminous output of the 400 watt high pressure mercury vapour lamp of this type may be about 15,000 lumens at mid-life, a similar calculation to that carried out above for the filament lamp shows that the lumens available per 100 feet of roadway in the case of the 400 watt discharge lamp lie between 5,500 and 6,500. In the case of a gas installation the whole unit, source and lantern, must be taken together. If the luminous output from a high-pressure lamp containing one mantle of the 1,000 c.p. (nominal) size and consuming about 30 cubic feet of 500 B.Th.U. gas per hour be taken

† The term " efficiency " is here used to denote the ratio of the total luminous flux given by the fitting to the total flux output from the bare lamp.

as about 9,500 lumens it follows that for lamps of this type, spaced at 150 feet, the lumens per 100 feet of roadway are about 6,300.

Although the sizes of lamps of the various types which have been chosen for the above examples happen to give not widely different figures of lumens per 100 feet of roadway, no lighting engineer will fall into the deplorable error of assuming that they will therefore *necessarily* be equally effective for street lighting. He will be well aware that, of two lanterns giving different luminous outputs, the apparently less efficient may be easily the better on account of its superior design, resulting in a more suitable distribution of the flux from the source.

This immediately raises the difficult subject of light distribution and here the committee are perforce driven to confine their recommendation to one of principle. "The distribution of light from the fittings," they say, "should be designed primarily to produce as uniform and high a background brightness as possible, subject to the avoidance of undue glare, whilst at the same time maintaining as high a contrast as possible between objects and their background. The background includes not merely the carriageway and footway surfaces, but also other surfaces such as those of buildings or fences against which objects may be seen."

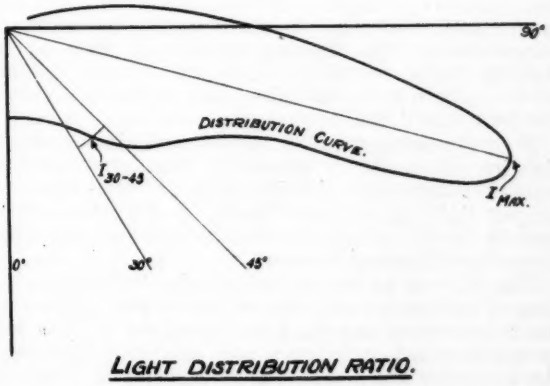
Probably it will be generally agreed that any more precise definition of the distribution to be aimed at is a matter appropriate to such a body as the British Standards Institution and perhaps it is not too much to hope that in a new edition of the Street Lighting Specification it may be possible to give designers and lighting engineers some definite guidance as to the lines on which to work. Nothing more than this, probably, is desirable, for the form of light distribution most suitable for street lighting in general is, necessarily, a matter upon which there may well be more than one opinion. In fact, it is probably safe to go still further and to say that there is no single "best" type of distribution but that quite widely different types may be most suitable for different conditions of use.

There is, however, one type of distribution which has been used quite extensively in the past and which the committee condemn whole-heartedly, no doubt with the cordial approval, not only of every public lighting engineer but equally of every motorist or other user of the highway. This is the type which throws out a highly concentrated beam of light at angles close to the horizontal in an effort to produce a high illumination at the mid-span point when the spacing-height ratio of the installation is far too large. The glare produced by such fittings is very serious, especially when the general background to objects on the roadway is low in brightness. As the committee point out, there are two factors which must be considered together in any treatment of the problem of glare. These are (i) the illumination produced at the observer's eye by the light source and (ii) the general brightness of his field of view. Other things being equal, it may be said that glare increases with increase in the first of these factors and decreases with increase of the second, so that to a first approximation the aim should be to keep the ratio of (i) to (ii) as small as possible.

A rough-and-ready way of achieving this object, at any rate to some extent, is to limit the *ratio* of the maximum (or peak) candle-power of a fitting to the amount of light which it sends downward on to the road surface. This expedient was adopted by the committee in their interim report, where they used a form of this ratio, which may be conveniently written as follows (see Fig. 1):—

$$\text{Magnification ratio} = \frac{\text{Peak candle-power}}{\text{Average c.p. in the zone } 30^\circ \text{ to } 45^\circ \text{ from the nadir.}}$$

Here the zone 30° to 45° from the downward vertical has been chosen as embracing that portion of the luminous flux from the fitting which is most effective in determining the general illumination of the roadway, and, therefore, the brightness of the observer's field of view. No doubt this method of trying to limit the glare in an installation is open to criticism from many points of view. Nevertheless, it will probably be recognised as marking a definite step



LIGHT DISTRIBUTION RATIO.

Fig. 1.

towards the solution of a problem which cannot, and must not, be ignored. The limiting value of this "magnification ratio" laid down by the committee for traffic routes is 6, with a recommended maximum of 5 in all cases, and a definite maximum of 5 when the "beams" from the fitting are directed axially along the roadway.

After referring to a matter which is governed by considerations quite distinct from those within the domain of the lighting engineer, i.e., the nature of the road surface, the committee pass on to the consideration of a comparatively new problem in street lighting, viz., the lighting of dual carriage-ways, the mileage of which is now increasing rapidly. Apart from a tentative recommendation that each carriage-way may be treated as a separate traffic route, the committee state that they are "reluctant to make definite recommendations," as

" there is need for considerable investigation before the most effective and economical method of dealing with the problems can be developed."

Technical Recommendations: Group B.

As explained earlier in this paper, the committee have placed in group B all roads which do not fall into group A. In other words, if an authority considers that a thoroughfare should be lighted at all, then if it does not fall into group A, it automatically falls into group B. It follows that there must be a considerable diversity in the nature of the various thoroughfares included in this latter group. Many, of course, are residential roads and roads in housing estates, others are fronted by factory buildings or the like, while some may be purely communication roads not fronted by buildings at all. A difficulty which not infrequently confronts the local authority is the changing character of some of the roads in group B, viz., roads which, although at present carrying purely local traffic, appear to be developing into traffic routes. There are two alternatives in the lighting of such roads. One is to treat them as already in group A in the expectation that the improved lighting will encourage traffic to use them and relieve the major traffic routes. The other is to treat them as in group B, and to make provision for conversion of the lighting system as soon as the through traffic seems to call for it. If care is taken with the siting of the posts, the conversion should not be unduly costly.

Before making detailed recommendations as to the lighting of roads in group B, the committee (in para. 76) deprecate the diversion of funds from the proper lighting of these roads to the provision of unduly lavish or spectacular lighting in the more important thoroughfares.

The objects to be served by the lighting in the case of residential and other roads in group B are set out in the report and the most important of them may be summarised as follows: (a) adequate lighting of the footways and kerbs, (b) mitigation of glare, (c) avoidance of dangerous or inconvenient shadows. and (d) the provision of adequate light for police supervision. The detailed recommendations of the committee may now be briefly stated. The mounting height prescribed is 13 ft. to 15 ft. with a definite preference for the upper limit. Spacing is closer than in the case of traffic routes (presumably on account of the lower mounting height), viz., an average of 120 ft. with an absolute maximum of 150 ft. in any one span. Even closer spacing than this is recommended " if it is economically practicable " and is enjoined at bends or where there are frequent intersections. The system of siting prescribed is kerb mounting with a staggered arrangement. As in the case of Group A, there is a wide range between the upper and lower limits for the amount of light recommended to be provided. In fact the range is even wider in this case. being 600 to 2,500 lumens per 100 linear feet of roadway. This extension of the range is doubtless largely due to the diversity in the classes of thoroughfare included. As the committee say: " The lower limit would be suitable for roads on housing estates and other quiet residential roads carrying but little vehicular traffic, and the upper limit for those roads which, whilst not coming within the category of traffic routes, carry considerable pedestrian and local vehicular traffic."

With regard to light distribution the limit prescribed for the " magnification ratio " (defined as in the case of traffic routes) is four, with a preferred maximum of three where the distribution is of the non-axial type, and three as a definite maximum where axial distribution is employed. The desirability of throwing some light on the lower parts of the fronts of buildings, for police purposes, is mentioned.

Technical Recommendations: General.

There are several matters upon which the committee make recommendations which are not confined in their application to either group of thoroughfares. One of these is the necessity for adequate maintenance: the committee's statement that " satisfactory maintenance is of no less importance than correct design " will be echoed by every lighting engineer. The committee indicate methods of testing the efficiency of the maintenance but state that the details should properly form part of the British Standard Specification.

The grading of street lighting where, say, a residential road enters a busy thoroughfare has often been recommended in the past. The committee discourage this and prefer to confine grading to cases where different parts of a single traffic route are lighted to different levels.

The vexed question of extinction or reduction of the lighting at midnight or 1 a.m. has evidently given the committee food for thought. For reasons which they state at some length, they have decided in favour of dusk-to-dawn lighting with the proviso that where the lighting is considerably above that recommended for traffic routes, e.g. in shopping areas, it may be reduced if and when desired so long as the reduced lighting is still up to the recommended standard.

With regard to the advantages of different systems of lighting under conditions of fog, the committee state their opinion that these conditions " are so diverse and so different from normal conditions that they cannot be regarded as a main factor in the design of normal street lighting installations." They add: " Special study appears to be required of measures necessary for the guidance of traffic during fog, and we do not consider it desirable that the design of installations should be prejudiced by special adaptation for fog conditions."

Conversion of Existing Installations.

A very important matter which will necessitate careful consideration on the part of many lighting authorities is that of the conversion or improvement of existing installations, especially where these are fairly satisfactory in most respects but differ in certain particulars from the committee's recommenda-

tions. Paragraphs 32 to 34 of the report deal with the subject at some length and the suggestions there contained may be summarised as follows:—

(i) A traffic route with unsatisfactory lighting should be re-lighted, if possible, to the standard recommended by the committee for Group A roads.

(ii) If immediate improvement to the full extent indicated in (i) is impracticable for financial reasons, there are two alternatives, viz. (a) to defer taking any action until (i) becomes possible, or (b) if the standard is at present below that recommended for Group B roads, to make an immediate improvement up to that standard and to follow, as soon as practicable, with improvement to the Group A standard. To effect an improvement such as would bring the standard of lighting between those recommended for Groups A and B respectively is specifically discouraged.

(iii) Apart from the siting of the posts, the characteristic of an installation which it is most expensive to alter is generally the mounting height. The replacement of installations which are otherwise satisfactory, but in which the mounting height is less than that recommended, should therefore be deferred until it becomes necessary on other grounds as well, at any rate where the present mounting height is 22 ft. or over.

Conclusion.

With two exceptions the remaining matters dealt with by the committee need not be mentioned here since they are either of minor importance or do not directly interest the lighting engineer. The recommendations with regard to illuminated guard-posts on street refuges are, however, of importance to many lighting authorities, while paragraph 117 is very pertinent and to quote it verbatim will fittingly conclude this brief survey of the report. "The recommendations which we have made in this report," say the committee, "are not intended to serve as a specification, and in our view they should be implemented, with the minimum of delay, by the issue of a formal specification by the British Standards Institution." *Verbum sapienti sat est.*

DISCUSSION

THE PRESIDENT, prior to the presentation of Dr. Walsh's address on the Report of the Departmental Committee on Street Lighting, said that of the nine members of that committee no fewer than four were members of the society. Some people, he continued, had been a little concerned as to what the report would contain and how far it would upset preconceived ideas. Designers of street lighting fittings, however, had been relieved to find that the report did not contain any wholesale condemnation of existing methods. Most people he thought welcomed the report, although not regarding it as absolutely infallible. No doubt there would be criticism of certain of the recommendations. Whether, however, the audience agreed entirely with the report or whether they doubted the wisdom of any parts of it, no one would doubt the wisdom of the council in asking Dr. Walsh, a past-president of the society and a member of the departmental committee, to present a summary of its contents.

Subsequently, the president, proposing a hearty vote of thanks to Dr. Walsh for his paper, said they had had an extremely lucid explanation of the report. The author had been through the report step by step and had put before the meeting not only the material in the report but had explained some of the ideas that were in the committee's mind and which led up to the recommendations. Such explanations would, he thought, eliminate a certain amount of criticism. The vote of thanks was carried with hearty acclamation.

Mr. E. J. STEWART (Glasgow), who opened the discussion, on the invitation of the council, said he regarded, as the greatest achievement of the committee, their success in obtaining a unanimous report—for he imagined that the views of the members were as diverse as were the conditions in the streets themselves. The author had given valuable help in securing good street lighting both in his official capacity and also as an old member of the B.S.I. Technical Committee which produced street lighting specifications. He knew the author had considered opinions of his own with which some people agreed and others did not agree wholely but which, nevertheless, must be weighed seriously.

The most serious consideration arising out of the recommendations in the report was the question of cost and who was to be responsible for it, and he knew local authorities would be looking for generosity in that respect from national quarters, whilst ready themselves to carry out the work. Personally, he had no objection to the degree of lighting proposed in the report, and, indeed, in Glasgow the important traffic routes were already lighted to the standards laid down in the report. His grievance, however, was that if the report was interpreted in too narrow a sense there would be roads on which the traffic conditions had changed and which were lighted in accordance with the recommendations for Group B when, in fact, the traffic conditions were such that the lighting ought to be in accordance with Group A. Speaking as a road user he maintained that although theoretically all streets with appreciable traffic ought to fulfil the requirements of Group A, in practice all streets in populous areas ought to do so. He presumed, however, that from lack of means we should continue for many years to have the paradox of headlights and glare in streets classed as Group B but which should be in Group A. If classified roads in populous areas were lighted to Group A standard it would be a tremendous achievement. He inquired in what way the attention of a driver on Group A roads was to be drawn to the fact

that he was entering a Group B road, and suggested that the fact that the use of headlights on Group B roads was at the discretion of the driver might lead to complaints, as the residents on these roads might have some views on the matter. The assessment of the claim for good lighting the committee had wisely left to the judgment of the local authorities and their engineers, as it did all other points which were likely to arise in the carrying out of the recommendations.

More detailed consideration was required with regard to some of the recommendations, and he believed the British Standards Institution was watching any points which might be brought out in the discussion with regard to changes from the standard specification as it now existed. The introduction of the lumen had come very peacefully. Flux was more definite than surface brightness and could be related to the simple method of many engineers of laying out their schemes for different kinds of streets in terms of heights and spacing and, as the maintenance of foot-candles told something of the distribution of the light, it remained to be seen whether a new method in the specification would be more satisfactory in this respect.

Opinion with regard to glare was a little less sure than it was a few years ago, but the recommendation in the paper should help to reduce glare even though it did not take all factors into account.

On the question of close spacing, Mr. Stewart said this might cause visual discontinuity in a street with a certain background. Lighting engineers knew the background they wanted, and in many cases it was quite good and helped in the distribution of the light, and the arrangement of the light sources.

The committee had recommended a very wide range of flux and there seemed to be scope for healthy competition between gas and electricity. The more precise definition of the distribution, however, seemed to be a matter for the B.S.I.

Mr. F. C. Smith (Chairman, Public Lighting Section of the Society) said he felt in rather a difficult position this evening since he had had a little to do with the technical work associated with the report. This evening, however, he was trying to place himself in the position of an engineer reading the report for the first time. At first reading everything seemed to be perfectly clear and simple to understand, but when one began to think more deeply about the report and to work out lighting schemes to be in conformity with its requirements it became apparent that there was need for a specification to give precise guidance in regard to detail. In fact, after further consideration it appeared to the speaker that the report left off just where things became difficult. There were a number of vague suggestions, and the general spirit of the report was that installations should be designed to promote good visibility. There was nothing new in this: in fact it had been the aim of street lighting engineers for years. The report indicated that the right way to get good visibility was to have high road surface brightness and to make sure that other essential bright backgrounds were well illuminated, in other words good visibility was to be obtained by producing the conditions necessary to promote seeing objects by silhouette. The report, however, gave no guidance as to how to judge the excellence of an installation. It particularly emphasised that lumen output was not a criterion to the excellence of an installation. In the absence of a suitable "yard-stick" there was no means by which the engineer or other interested party could judge the installation: in this respect the report left everyone in the air.

Referring to the glare clause he was not at all sure that this dealt successfully with the problem. In fairness, however, he hoped he would not be asked to draft a suitable clause.

He was amazed in regard to the recommendations in respect to mounting heights, and he would like to be informed how it was that when dealing with a Class B road the mounting height of 13-15 ft., with a lumen output of 2,500 lumens per 100 linear feet of roadway was recommended, whilst on a Class A road, in order to secure good visibility, it was necessary to mount the sources 25 ft. up and have a lumen output of 3,000 lumens per 100 linear feet of roadway. Was there any scientific or logical reason for this very great difference in mounting height? There was very little difference in the lumen output, but apparently the report suggested that putting up standards 25 ft. high made the difference between the need for using headlights on Class B roads and not using them on Class A roads. That might be right but he very much doubted it.

Again he felt the committee was definitely wrong in excluding fog conditions from their considerations. The committee was appointed to deal with matters affecting safety on the roads, and drivers knew how difficult it was to drive under fog conditions. The reason put forward by the committee was that there were said to be comparatively few nights when fog conditions prevailed, and presumably installations which must be capable of dealing with fog conditions were not the most suitable installations for the ordinary state of affairs In his view there was a great deal to be said for low mounting heights on roads which were not too wide. Units mounted at from 13-15 ft. at relatively short distances apart were capable of giving excellent visibility under ordinary circumstances and were helpful under fog conditions.

In the case of wider roads, there was, perhaps, need for the greater mounting heights.

Referring to the lighting of bends, he was by no means clear how the recommendations of the report could be applied to deal with the lighting of S-bends.

On the question of maintenance, the committee might have been a little more courageous than merely expressing a pious hope that maintenance would be carried out. It was important to put into the contract some obligation in this respect, stipulating in some very definite way how the maintenance of the installation could be checked up. He would suggest that the light output should never be allowed to fall below 70 per cent. of the normal value. Here, again, the difficult point of maintenance requirements had

been referred to, but it had been left to others to make these requirements definite.

Mr. C. R. BICKNELL, referring to various difficult points on which the committee had taken no decision, pointed out that paragraphs 48 and 107 in the report seemed to involve some contradiction. In the latter paragraph the exercise of care in siting name-plates in relation to street lamps, so that they could be read without difficulty, was emphasised. Paragraph 48, however, suggested a position for lamps in relation to cross-roads which would not enable the street name-plates to be seen.

Mr. Bicknell also drew attention to the statement (paragraph 77 (c)) that where the casting of heavy shadows, e.g., by trees, was unavoidable, care should be taken that they did not fall along the kerbs or across the carriageway. He did not see how this admittedly desirable feature could be obtained with a maximum mounting height of 15 ft., which precluded the unit overhanging the kerb line. If the height could be increased to, say, 19 ft it would be possible to mount the unit with a projection beyond the kerb line which, in many cases, would preclude the formation of shadows, and in others reduce them.

In regard to the dazzle ratio, it was common practice to reduce the light-emission from the pavement side of a lantern to obviate annoyance to householders, and in some cases it was necessary to blank out this side completely. Now it was laid down in paragraphs 62 and 63 of the report that the ratio of peak candle-power to the average value *in all directions* downward from the source and lying between 30 degrees and 45 degrees from the verticle should in no case exceed six. It was conceivable that a perfectly good lantern with a low dazzle effect might, on paper, be inadmissible, owing to the treatment on the house side such as that mentioned above—which treatment could surely have little, if any, effect on disability glare.

Mr. T. N. RILEY, speaking as a user rather than a technical expert, said he was wondering why it should be taken for granted that it was necessary to try to produce maximum contrast in street lighting, when as far as eye comfort was concerned it was a thing to be avoided in every other kind of lighting. In his view there was greater comfort in a lower level of illumination than that envisaged in the report, provided it was reasonably uniform—the condition of bright moonlight, for example. In night driving, at least 50 per cent. of the background was black, and it did not seem to him that it would be easier to see if the brightness of portions of the road surface was accentuated, particularly if lamps with no cut-off were used. Continuing, he said he had some difficulty in understanding what was meant by the "general level of adaptation" in a visual field including such wide extremes of brightness. Speaking as a motor-car driver, he said that the kind of lighting which he found easiest to drive in was the light from shop windows on each side of a road. For that reason he asked if the committee had considered lighting across the street rather than along it. Were there any fundamental objections to this? In built-up areas it might be possible to mount fittings on buildings and cheapen an installation by omitting posts altogether. With cross-lighting there need be no bright sources visible to the driver to cause glare. Admittedly, the brightness of the road surface would be less, but the actual visibility, as distinct from brightness, might be considerably greater. This form of lighting might also make it possible to light footpaths more effectively than at present. Therefore, he would like to know if, in assessing installations, any real tests of comfort of driving, as distinct from static measurements were made by the committee; and whether any alternative method of lighting, comparable to lighting from the side, was considered or tested.

Mr. S. PATMORE, remarking that the recommendation in the report as to the appointment of fully qualified street lighting engineers was of great value, suggested that the Society and the Association of Public Lighting Engineers would do well to hasten the day when they could issue certificates which would definitely give every lighting engineer evidence that he was fitted for such a job. It was, he continued, a matter of some surprise to him that the report did not mention systems of control of public lighting, because now that so much attention was being paid to air raid precautions, some recommendations in that direction would have been very useful to public authorities and others.

Mr. G. H. WILSON, expressing satisfaction that the last speaker had struck an optimistic note, and remarking that Dr. Walsh had been enthusiastic in his discussion of the Report, said that it sounded as though Mr. Smith had tried to send everybody down to the depths of despair, and he was wondering what was going to be the reaction of the Report on the average lighting engineer, or the average member of a Council, when he tried to interpret it and use it. Was it really going to be as bad as Mr. Smith had said, or would they all be optimistic like Dr. Walsh? He could not help feeling that Mr. Smith was asking too much when he wanted the Report to indicate a method of evaluating the excellence of street lighting. Personally, however, he thought the Report achieved something else. When some of the modern street lighting systems were installed in the early days—installations which more or less complied with the recommendations of this Report—the general impression of the members of the public was that these early installations were excellent and better than most they had seen before. Therefore, if street lighting installations in the future were carried out in accordance with the recommendation of the Report, it seemed to him that the reaction of the public would be that these installations were excellent. The Report did lay down the fundamental principles of an installation which the public would judge in that way. It was not an easy matter to design installations for the difficult cases pointed out by Mr. Smith, but with a certain give and take, and compromise as to the positions, it was possible to layout an installation which

would give very good results, without a great expenditure and without having the posts extremely close together.

With regard to the technical recommendations, Mr Wilson remarked that the investigatory work which had been done recently and on which, he believed, many of the recommendations in the Report were based, indicated that the order of the items in the Report was not necessarily the order of importance in obtaining visibility in an installation. His own feeling was that the most important item was the placing of the posts in the installation. If the posts were not in good positions it was difficult to get a good lighting result by increasing the lumen output or increasing the height. Second in order he would put the height of the unit, and, thirdly, the amount of light given out by the unit. The fourth item, in order of importance, was the distribution, taking the glare clause into consideration, and he believed it would help planners of installations and Councils who were considering installations to comply with the Report if emphasis was placed on the various clauses in the order he had just mentioned.

Mr. E. S. PERRIN, remarking that Mr. Smith seemed to be in some trouble, said he thought the meeting ought to know that the Committee was also in some trouble. It asked several organisations to appear before it and give the benefit of their advice, and one of their recommendations was that it was essential that a qualified lighting engineer should be appointed to look after the lighting installations in any area as no report or specification could be framed to cover all conditions. If the Committee had been able to lay down a complete specification to cover all cases, no lighting engineer would have been needed, but it was the need for the lighting engineer to exist that led the Committee to adopt this recommendation. The Committee, therefore, laid down the principles which the lighting engineer should follow, and had advised the Minister what those principles were.

Mr. J. R. HEPPLE said it would be interesting to know if any publication, other than the anticipated specification, was likely to follow this Report, which merely made recommendations. Further, was it the intention of the Ministry to bring into operation, in a compulsory manner, the recommendations in the Report. If so, would a time limit be fixed within which local authorities must bring their installations up to the required classification, and this, of course, involved the question of expense. There were many County Boroughs and small local authorities in which the product of a penny rate was of paramount importance, but would be a comparatively small sum compared with the cost of bringing the roads up to Class A or Class B. Was it likely, however, that some other class would be allowed because there were several local authorities which would never be able to raise the money to pay for Class A and Class B installations?

With regard to maintenance, the existing specification for street lighting allowed a tolerance of 50 per cent. Probably the same tolerance would be allowed in the specification to be published, and it would be interesting to know whether an installation which had to provide a certain definite number of lumens per 100 linear feet of road would have to bear a margin on the higher side so that, when the figure for tolerance was allowed, the installation would not be below the number of lumens recommended in the specification.

Finally, on the question of glare, Mr. Hepple said that he had found that the correct use of prismatic refractors had a useful effect in reducing glare from lighting sources.

Dr. C. C. PATERSON suggested that "magnification ratio" was not a happy term for what was intended to be a gauge of dazzle——nor was it used in the final report. He hoped a term more descriptive of the actual ratio defined could be found.

Mr. E. STROUD pointed out that the "magnification ratio" as the ratio of the peak candle power over the average in the zone from 30 degrees to 45 degrees could not be a direct measure of glare, but merely serve to limit the peak candle power.

One doubts very much whether the zone 30 degrees to 45 degrees from the downward vertical embraces that portion of the luminous flux which is most effective in producing brightness in the observer's field of view.

Much higher brightnesses are obtained from the direct reflection of beams given at much higher angles.

Again, if there is any merit in the ratio surely it should not be the average in the zone 30 degrees to 45 degrees, but the average in the "field of view" at any one position.

The question of overhang deserved attention. In the Interim report, 6 ft. overhang was specified, but this had now been amended.

The final report indicates that overhang tends to reduce visibility near the kerb. Mr. Stroud said that, in his opinion, it is more important to ensure visibility near the kerb than in the centre of the roadway; he would, therefore, advocate less overhang than that given in the report, although the committee have reduced the amount originally recommended. This, he thought, was important because the greater number of accidents in driving took place near the kerb.

The lantern efficiency figures given by Dr. Walsh at the bottom of page 3 are rather low and should be corrected. From tests taken lately by the N.P.L. on modern refractor types:

Lanterns with Gas-Filled Lamps gave a 75 per cent. light output.

Lanterns with Mercury E.D. Lamps gave a 74 per cent. light output.

Lanterns with Sodium E.D. Lamps gave a 74 per cent. light output.

With group "B" roads it is recommended that posts be placed close to the kerbs with no overhang. Surely if overhang is necessary in group "A" roads, then it should be equally so in group "B." It would seem that the non-overhang recommendation is simple due to the fact that at the heights recom-

mended for group "B" lanterns could not be overhung, due to traffic considerations.

Mr. A. CUNNINGTON (*communicated*) said that whilst fully appreciating the practical value of the Report in relation to present-day street lighting, he could not help feeling some disappointment at the fact that it had rather stressed the practice of to-day, or even yesterday, and had not said sufficient about the possibilities of to-morrow. He was not unmindful of the fact that the Report had to be practical; also that if it had dealt only with the principles of street lighting in a vague and general way it would not have been of much service to Local Authorities, who wished to know where and at what height they should fix their lamps and what form of lantern of given candle-power should be adopted.

But was there going to be no other system of street lighting during the next ten years except by staggered lamp-posts 25 feet high and 150 feet apart? Could not the Report have at least indicated certain other trends of lighting and have preserved a more open attitude towards the future? Paragraph 56, in dealing with distribution, commented on the use of a cut-off in order to avoid glare, but it abstained from making any recommendation to this effect. And yet, surely, no impartial observer who had been present at the demonstrations in the streets of Folkestone a few months ago could have failed to appreciate the greatly improved value of the lighting where cut-off fittings, with rather closer spacing than usual, were employed.

His own experience in connection with railway lighting of platforms had served to reinforce his views with regard to glare. He recalled a case some years ago—the replacement of certain glaring lamps, fixed at fairly wide intervals on a platform, by about three times the number of smaller units completely shielded—where the effect on improved visibility on the platform was almost magical, without any appreciable increase in running cost.

The only objection he could ascertain in regard to such systems of lighting as that observed at Folkestone was that it might cost somewhat more than the normal method. But was it not our first task as illuminating engineers to indicate the best method of lighting, and only secondly to apply our research towards reducing cost? It was a question for the street lighting authorities whether or not they could afford the best. Moreover, in view of the rapid progress being made towards improved efficiency of units of comparatively low power, was there not a great possibility that the use of small units at more frequent intervals on some simple catenary suspension might prove successful in the near future?

We would look forward with interest to the new B.S.I. specification for street lighting. The machinery in this case provided for frequent revision, and he hoped that possible future developments would not be overlooked

Mr. J. S. Dow said that he, like Mr. Cunnington, felt that more attention should be devoted to the elimination of glare in street lighting. He would therefore like to see "cut-off" installations studied more seriously. The conception of street lighting as involving very powerful sources, with a high candle-power at angles somewhat below the horizontal and mounted on very high posts, seemed to be in part a survival from the past, when even distribution of illumination between posts was the main objective. Modern views were based rather on the production of high and even road brightness. For this purpose it was necessary to study the reflected images of light sources. The greater the number of images available the better, surely, the chance of avoiding dark areas. A large number of sources of modern brightness mounted at intervals might be better than a few intensely powerful lights at great distances apart.

Such circumstances as the adoption by Local Authorities of somewhat closer spacing than that suggested in the Report, or of new methods of road surfaces, might well alter the future technique of street lighting and thus render necessary considerable modifications in the recommendations made at the present moment. It was hoped, therefore, that the Report would not be regarded as containing fixed and unalterable suggestions and that the Ministry would be alert to revise their recommendations from time to time.

Dr. J. W. T. WALSH, replying to the discussion, said he believed that the light-consciousness of the public was the key to better street lighting in the future because if the public wanted better street lighting it would have it. Whilst he did not say that the financial difficulties mentioned by Mr. Stewart would disappear, they were capable of being overcome if there was sufficient demand from the man in the street, using the phrase in its most literal sense. The answer to Mr. Stewart's concluding question seemed to be that when a driver on a Group A road entered a Group B road, he would be made aware of that fact most unmistakably by the sudden drop in the mounting height.

It had been asked by Mr. Smith, the pessimist, how the committee would judge or suggest that anyone should judge the relative excellence of two installations. Personally, he did not think the committee would attempt anything so difficult and he was not sure that, even with a British standard specification, it would necessarily be a desirable thing to do. If an installation gave good service he did not think that it need be compared with some other installation which was also giving good service. The same thing applied to a gas cooker. If he had a cooker which cooked his dinner satisfactorily and gave him satisfaction, he did not necessarily want to compare it with Mr. Smith's cooker, which also did a satisfactory job.

It was rather difficult to answer Mr. Smith when he asked for a logical reason for suggesting 2,500 lumens as a maximum for Group B roads on 13 ft. to 15 ft. posts, and 3,000 lumens on a 25 ft. post for a Class A road. Turning to the relevant part of the report itself, Dr. Walsh said it seemed to him that although this was probably not a complete answer, the clue to the answer lay in the fact that the lighting requirements, as envisaged by the committee,

were rather different for the two cases. The first of the requirements in the case of Class B roads was that the footway should be adequately lighted and that the kerbs should be clearly defined to pedestrians and motorists, whereas for Class A roads the chief objects to be achieved were altogether different. He did not agree with Mr. Smith in what he said concerning fog conditions. He definitely felt that to attempt to deal with the problem of guiding traffic in fog by means of the ordinary street lighting system was to run a severe risk of spoiling the installation for normal conditions of use.

Maintenance was, of course, a most important matter but the committee had clearly been of the opinion that it was best left for detailed treatment in the hoped-for standard specification. No doubt when this was done the important question raised by Mr. Hepple would also be answered quite unambiguously.

With regard to Mr. Bicknell's question concerning the lighting of street nameplates, the report said that the nameplates should be brought to the light and therefore there was no necessity to worry about the position of the street lamp in that connection. As to the shadow difficulty, he appreciated the point made by Mr. Bicknell but it seemed to him that if it was not possible to overhang the street lamp because it was less than 19 ft. above the kerb, the logical thing to do was to clear away the overhanging branches of trees up to 15 ft. (or whatever was adopted as the mounting height) above the roadway and then, presumably, the shadow would disappear. The question of the dazzle ratio and the blanking out of one side of the lantern was a real difficulty which had to be met, and he had no doubt that the new specification would deal with that point.

Several speakers had referred to the dazzle ratio, and he had to confess having coined the term "magnification ratio." As a matter of fact, the committee had exercised a considerable amount of ingenuity to avoid calling that ratio anything at all, and he hoped that before long some convenient term would be suggested. He agreed with Mr. Stroud that it was the average brightness in the field of view that mattered; the committee's method was nothing more than a rough-and-ready substitute which would probably be found adequate in most cases.

Mr. Riley's suggestion to arrange sources transversely across the street was a very interesting one, but it would mean a good deal of experiment to determine whether such a plan was feasible from the economic point of view.

Mr. Stroud's criticism of the figures of lantern efficiency given in the paper was an illustration of what he would say to those speakers who had criticised the report on the grounds that it gave only general guidance and was not a specification. He would emphasise the fact that street lighting was still a rapidly growing and very fluid subject. Mr. Stroud had stated that the figures of efficiency given in the paper were too low. As a matter of fact, these figures were some months old, and it was not improbable that the figures which Mr. Stroud had given would, in turn, be too low in twelve months' time. The whole thing was developing and improving all the time, and if the committee had attempted to draw up a specification he personally would have hoped that it would be completely out of date in two or three years' time. Indeed, he hoped that that would happen to the new B.S.I. specification. He cordially agreed with Mr. Cunnington and Mr. Dow that we should allow nothing to stand in the way of improvement, however radical might be the changes required, and however much we might have to scrap our prejudices and open our minds to unorthodox or even revolutionary suggestions.

A Street Lighting Film Demonstration.

At the conclusion of the discussion an experimental film, which had been prepared by Mr. C. Dunbar, of the National Physical Laboratory, was exhibited. It was explained that the film was prepared in connection with work being carried out for the Illumination Research Committee of the Department of Scientific and Industrial Research, which was interested in the relative merits of different coloured lights for carrying out various kinds of work. Street lighting, it was said, had come into this work more or less accidentally, but the object was to show the effect with different kinds of lighting, i.e., mercury light, sodium light, and "white" light. For the purpose of this work it was impossible to use actual street lighting installations, and therefore the film was made from a series of ordinary still photographs. These were made, all from the same point, with the street empty and with various objects placed at different points on the carriageway or footway. By means of holes made in the projection screen at the positions of the street lamps, each hole being appropriately lighted from behind, it was possible to get correct contrasts throughout the picture and so to imitate an actual street with fair accuracy.

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With a view to avoiding possible confusion with other publications, reference to these Transactions should be in the form:—"Trans. Illum. Eng. Soc. (London)."

Printed by the Argus Press, Ltd., Temple-avenue and Tudor-street, London, E.C.4, England.